**TECHNOLOGY BRIEF**

**February 2021**

New stress-resilient and highly productive pigeonpea for semi-arid ecologies

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*Two new pigeonpea varieties are ideally suited to semi-arid ecologies, such as the central zone of Tanzania. They mature faster than the local varieties, securing earlier harvests and better food security, as well as producing 70% higher grain yields.*

Key messages

* Early harvest: Matures in as little as 180 days
* High productivity: Produces 70% higher yields than local varieties
* Food for the ‘hunger gap’: Provides valuable food supply and income at a time when other crops are not being harvested

# Description of the technology

The early-maturing, highly productive varieties Ilonga-14-M1 (ICEAP 00554) and Ilonga-14-M2 (ICEAP 00557) are new, commercially available varieties of pigeonpea (*Cajanus cajan* L.). The new introductions are ideally suited to semi-arid ecologies, such as Tanzania's central zone, where increasing climate variability threatens the productivity of longer-duration varieties. The new pigeonpea varieties mature after only 180 days, compared with 240 days for improved longer-duration varieties. Under optimal growing conditions (on-station), the new Ilonga varieties can yield 1700–2000 kg per hectare, representing a 70% yield advantage over local checks. On-farm yields of between 1000 and 1500 kg per hectare have been recorded.

The new varieties are tolerant to fusarium wilt (*Fusarium udum*), a soil-borne pathogen that is endemic to Tanzania and many other pigeonpea-growing countries. They also have good market qualities (cream in color with medium to large seeds, 100 seed weight of 14 g, and amenable to machine dehulling). Both varieties have been released in Kenya, Malawi, Mozambique, Uganda, Zambia, and Tanzania.

As a semi-perennial shrub, pigeonpea has many advantages over annual legumes. Farmers can harvest several grain crops per year, and the crop has a much higher capacity to contribute to enhanced soil health. The crop is being promoted increasingly as a component of sustainable intensification in farming systems in semi-arid ecologies due to its multiple uses as food, fuelwood, and a cash crop. With many farmers viewing livestock production as insurance against crop failure, pigeonpea biomass also provides a useful fodder source.

# Conditions that favor uptake

**Agro-ecological conditions:** Pigeonpea is a semi-perennial leguminous shrub with a deep taproot system. It is well adapted to semi-arid agro-ecologies (average annual rainfall of 200–700 mm) since it can access water from deep in the soil profile. The crop grows well in deep soils within latitudes 30° North and South of the Equator at an altitude of between 20 and 1200 m above sea level. It requires 10–11 hours of daylight and temperatures of 22–24°C for optimal flower set.

**Access to inputs and markets:** Uptake of the new varieties will depend on farmers having access to adequate seed, and this will require investment in the formal and informal seed sectors. However, farmers often recycle their seeds for several generations, which does not incentivize private-sector investment. Early-maturing pigeonpea is particularly susceptible to pests such as pod borers. Farmers will need access to pesticides to control them or apply crop rotation to limit soil-borne pathogens' build-up. There is an increasing demand for the pigeonpea grain for markets within Africa and a significant export market to South Asia. Benefiting from these markets will require the expansion of collective marketing by farmers and stronger links throughout the value chain. The development of national breeding programs and seed certification institutions is also necessary to ensure farmers can access the new varieties' quality seed.

# Alignment with household resource endowments

In semi-arid agro-ecologies, such as central Tanzania, crops are required to have multiple functions. Pigeonpea meets these requirements as it can be grown as an intercrop with cereals (maize, sorghum, and pearl millet) or with other legumes (as in the ‘doubled-up legume’ cropping system). Pigeonpea provides a valuable source of dietary protein and other micronutrients. It is also an important source of income, with many farmers selling up to 75% of their produce. Pigeonpea has high biomass productivity (up to 3.5 tons per hectare) and can be used or sold as livestock fodder or fuelwood. A vital feature of the early-maturing varieties is that they can be harvested when few other annual crops are available; pigeonpea thus provides an important food and income source to bridge the supply gap. Since the new varieties produce up to a 70% yield advantage compared to local checks, they present an important asset for building food security and smallholder livelihoods.

# Necessary ingredients for implementation

**Planting and intercropping:** Both varieties should be planted at a spacing of 100 cm between rows and 30 cm between plants. The seed rate is 15 kg of seed per hectare. For intercropping, a farmer may use a spacing of 100 cm between rows and 50 cm between plants, generating a population of 20,000 plants per hectare. The crop should be planted in deep sandy loam soils with a pH of 5.0–6.2 to support the taproot system's development. The crop requires limited soil amendments and so may not require the application of inorganic fertilizers. It is crucial to grow pigeonpea in rotation with a cereal to minimize the build-up of soil-borne diseases, such as fusarium wilt.

**Crop management:** Pests and diseases are among the key constraints to pigeonpea production and include pod borers (Lepidoptera), pod-sucking bugs (Hemiptera), and seed-feeding pests (Diptera and Hymenoptera). If not managed, these pests can cause considerable yield losses culminating in near-total crop failure. Infestation usually peaks at about 90–100 days after planting, when the pods are developing, and pesticide application must be timed to control pests at this critical stage. Two or three systemic pesticide applications (based on the pest load, e.g., a pyrethroid such as cypermethrin) are effective. The significant disease is fusarium wilt, which is more common in systems with poor crop rotation. While pigeonpea is generally robust in its later growth stages, young plants can be quickly smothered by weeds, with the potential for up to 30% yield losses. Three weeding sessions performed between three and six weeks after planting will eliminate weeds and reduce pest populations' build-up. The harvested mature grain should also be protected from insect damage using Purdue Improved Crop Storage (PICS) bags. This hermetic storage system allows farmers to store grain without the use of pesticides.

# Adaptation possibilities

**Crop integration:** To minimize competition for light, water, and nutrients and exploit differences in crop growth patterns, pigeonpea should be intercropped with plants that mature early, i.e., with cereals (sorghum, pearl millet, and maize) and legumes (groundnut). For best results, the additional crops should be established in alternate rows to avoid shading the pigeonpea. The ‘doubled-up legumes’ technology is particularly beneficial for improving soil health and fertility and will generally positively affect cereal yield in a successive rotation.

**Agro-ecology:** Pigeonpea is well adapted to semi-arid ecologies, where families are prone to food insecurity. The new early-maturing varieties have been evaluated and released in all pigeonpea-producing countries of East and Southern Africa, with a further evaluation conducted in Tanzania's semi-arid zones. They have been well accepted by mixed crop-livestock farmers.

African soils are commonly degraded, heavily leached, and characterized by limited available phosphorus. Pigeonpea adds nitrogen to the soil and is therefore useful for improving soil fertility. It also mobilizes phosphorus from the soil, releasing it onto the soil surface through leaf-drop and making this nutrient available to the next crop.

# Potential benefits to users

**Food security:** Early-maturing pigeonpea provides food for the ‘hunger gap’, at a time when cereal crops have been harvested and sold. The new varieties produce higher grain yields per hectare than long-duration or local types. When grown under optimal conditions, the new varieties yield to 1,700–2,000 kg per hectare, providing more than a 70% yield advantage over local checks.

**Nutrition:** Pigeonpea grain is a rich source of dietary protein, energy, and micronutrients (phosphorus, magnesium, calcium, potassium, and iron). Pigeonpea is also rich in dietary fiber, which is essential for digestive health.

**Increased incomes:** Early-maturing pigeonpea has the potential to become an important cash crop throughout East and Southern Africa, with farmers reporting incomes of more than USD 800 per hectare in a good year. In addition to the grain harvest, farmers can sell pigeonpea biomass for livestock feed and fuelwood.

**Soil fertility:** Pigeonpea leaf-fall, when incorporated in the soil, can add up to 40 kg of nitrogen per hectare. The plants can also mobilize phosphorus from the soil and make it available to subsequent crops, together with other deeply leached nutrients.

# Things to worry about

**Pests and diseases:** Early-maturing varieties of pigeonpea are exposed to relatively high pest pressure, requiring farmers to apply pesticide two or three times in one season. Fusarium wilt is another common problem; this can be managed by crop rotation with cereals.

**Labor and training**: Pigeonpea production is labor-intensive in the early stages of planting, weeding, and pest control. It also requires processing and careful storage in PICS bags or other airtight facilities after harvest. Farmers, therefore, need access to training on crop management to gain the best results.

**Market risks:** In East and Southern Africa, pigeonpea is grown mostly as a cash crop for export. The crop can be a risky investment due to fluctuating grain prices.

# Where was the technology validated?

The new varieties were released commercially in Tanzania in 2014. Adaptability trials were conducted between 2016 and 2020 in the semi-arid zone of central Tanzania at the Tanzania Agricultural Research Institute, Hombolo station, with on-farm evaluations undertaken in two districts (Kiteto and Kongwa). The trials assessed adaptability and suitability for the local environment and cropping system through on-farm testing, participatory variety selection, and results demonstrations.

Kiteto district lies at 1087 m above sea level. It has weather conditions varying from semi-arid to sub-humid, with an average annual precipitation of 682 mm and an average temperature of 19.5°C. Kongwa district lies at 1120 m above sea level and has an average yearly rainfall of 556 mm and an average temperature of 28°C.

[insert map]

# Images

Please send the original jpeg files for these images together with captions and credits.

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| A group of people standing in front of a crowd  Description automatically generated | A plant in a garden  Description automatically generated |

Artwork: can be based on that prepared for the ‘Doubled-up legumes technology’ brief, with the crops featuring pigeonpea and sorghum (instead of maize). Maybe also include an image of the sun, or make the ground look dry, to signify ‘semi-arid’.